

MODELING OF SHALLOW WATER ACOUSTIC MODE VARIATIONS IN THE STRAITS OF FLORIDA

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SHALLOW-WATER ACOUSTICS

LONG-TERM GOALS

This research will focus on understanding the variability of acoustic propagation in shallow water areas by examining the fluctuations of acoustic mode energies in response to oceanographic changes not related to internal waves. The long-term goal of this research is to develop an understanding of the relevant bottom-loss mechanisms (more stripping and mode coupling) in shallow water areas by examining mode amplitude distributions as a function of oceanographic fluctuations with geotime.

SCIENTIFIC OBJECTIVES

The objective of this research is to continue the data analysis as described in [1]. The objective for 1997 is to model both the oceanographic mode and acoustic mode variations through geotime from the Florida Straits experiment. Time series of mode amplitude distributions for both the acoustic and thermistor data will be generated in an effort to understand the variability of bottom loss in shallow water regions.

APPROACH

Empirical Orthogonal Function (EOF) analysis will be performed on the thermistor data as a prerequisite to the acoustic model runs. The EOF analysis computes the variational modes of the temperature field, yielding a highly accurate representation of the sound speed profile over the entire water column. This effort will yield not only the inputs to the acoustic models, but also time histories of the oceanographic variational mode amplitudes.

A detailed numerical analysis will be made using range dependent PE (UMPE) and normal mode (KRAKEN) models. UMPE will be used to compute the 950 pulse responses from the North/South leg of the October acoustic experiment. Acoustic modes will be generated using KRAKEN. Using the complex pressures from UMPE and the modes from the KRAKEN result, mode amplitudes are computed for each measured pulse response. The research will then examine the nonadiabatic behavior of modal energies as a function of geotime and range. In this way the effects of the variation of mode stripping and mode coupling on the acoustic data can be investigated with respect to the oceanographic mode variations.

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WORK COMPLETED

Several months were invested in accomplishing the EOF analysis. Accurate inputs to the acoustic models are a priority. The EOF analysis has generated sound speed profiles at multiple ranges along the acoustic track for every hour of the 40-day experiment.

Before full scale production runs of the UMPE model, model inputs (both environmental and numerical) were resolved. Using a test case, inputs were selected which generated a broadband result which, not only matched the data, but also afforded the numerical resolution to compute the mode amplitudes accurately.

Full scale broadband production runs of the UMPE and KRAKEN models are ongoing. To date, approximately 40% of the broadband results are done. Computed broadband results match the measured pulse responses to a high degree.

The routine to decompose the normal mode amplitudes is being developed.

RESULTS

EOF analysis is an extremely useful tool for representing highly variable sound speed profiles in shallow water areas.

UMPE accurately predicts the especially difficult surface ducted arrivals, provided numerical inputs are not compromised.

Generation of mode amplitude time series is being pursued. Mode stripping should be dominant for near linear profiles while mode coupling should dominate for profiles highly variable with depth.

IMPACT & APPLICATIONS

The results of this research will lead to a better understanding of scintillation in shallow water channels.

TRANSITIONS

The results of this research should serve to emphasize the importance of coastal oceanographic processes, not related to internal waves, on the variability of shallow water acoustic propagation.

RELATED PROJECTS

This work relates to most shallow water propagation modeling efforts where coastal oceanography leads to highly variable acoustic propagation.

REFERENCES

- [1] C.L.Monjo, N.B.Nguyen, and H.A. Deferrari, 'Modulations of detectable pulse response time spread in shallow water resulting from a combination of sound-speed variability and bottom loss,' J. Acoust. Soc. Am. 102, 2083-2097 (1997).